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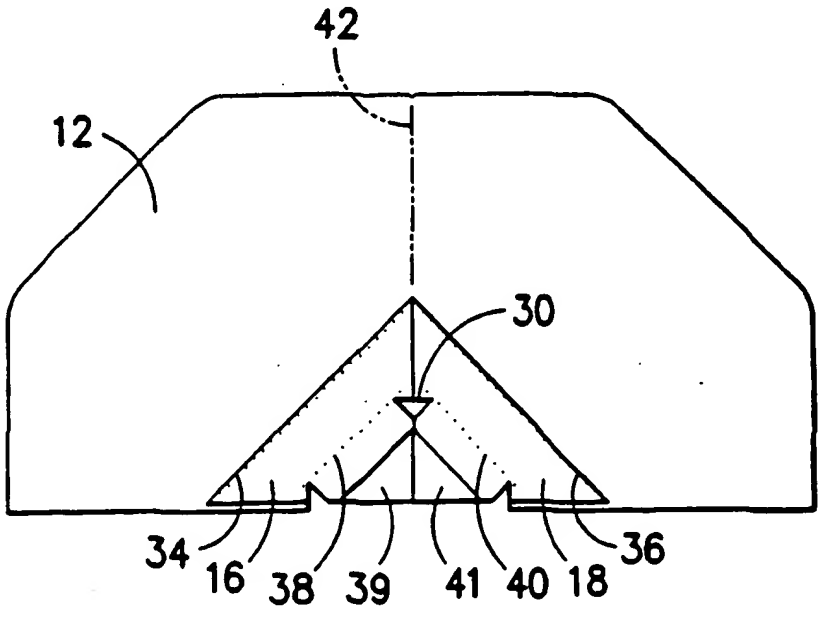
(54) Title: AIRBAG USING LOW SEAM AND FABRIC



(57) Abstract: The present invention relates to an airbag cushion (50) which simultaneously exhibits a low amount of seam usage as well as a very low amount of fabric utilized to produce the target airbag cushion (50), both in correlation to an overall high amount of available inflation airspace within the cushion (50) itself.

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Background Art

All U.S. patents cited herein are hereby fully incorporated by reference.

Inflatable protective cushions used in passenger vehicles are a component of relatively complex passive restraint systems. The main elements of these systems are: an impact sensing system, an ignition system, a propellant material, an attachment device, a system enclosure, and an inflatable protective cushion. Upon sensing an impact, the propellant is ignited causing an explosive release of gases filing the cushion to a deployed state which can absorb the impact of the forward movement of a body and dissipate its energy by means of rapid venting of the gas. The entire sequence of events occurs within about 30 milliseconds. In the undeployed state, the cushion is stored in or near the steering column, the dashboard, in a door, or in the back of a front seat placing the cushion in close proximity to the person or object it is to protect.

Inflatable cushion systems commonly referred to as air bag systems have been used in the past to protect both the operator of the vehicle and passengers. Systems for the protection of the vehicle operator have typically been mounted in the steering column of the vehicle and have utilized cushion constructions directly deployable towards the driver. These driver-side cushions are typically of a relatively simple configuration in that they function over a fairly small well-defined area between the driver and the steering column. One such configuration is disclosed in U.S. Patent 5,533,755 to Nelsen et al., issued July 9, 1996, the teachings of which are incorporated herein by reference.

16, 1996; U.S. Patent 5,503,197 to Bower et al. issued April 2, 1996 and U.S. Patent 5,704,402 to Bowen et al. issued January 6, 1998, all of which are incorporated herein by reference.

As will be appreciated, the permeability of the cushion structure is an important factor in determining the rate of inflation and subsequent rapid deflation following the impact event. In order to control the overall permeability of the cushion, it may be desirable to use differing materials in different regions of the cushion. Thus, the use of several fabric panels in construction of the cushion may prove to be a useful design feature . The use of multiple fabric panels in the cushion structure also permits the development of relatively complex three dimensional geometries which may be of benefit in the formation of cushions for passenger side applications wherein a full bodied cushion is desired. While the use of multiple fabric panels provides several advantages in terms of permeability manipulation and geometric design, the use of multiple fabric panels for use in passenger side restraint cushions has historically required the assembly of panels having multiple different geometries involving multiple curved seams.

As will be appreciated, an important consideration in cutting panel structures from a base material is the ability to maximize the number of panels which can be cut from a fixed area through close-packed nesting of the panels. It has been found that minimizing the number of different geometries making up panels in the cushion and using geometries with substantially straight line perimeter configurations generally permits an enhanced number of panels to be cut from the base material. The use of panels having generally straight line profiles has the added benefit of permitting the

for passenger-side airbags which, as noted previously, require greater amounts of fabric for larger volumes of air (gas) to provide the greatest amount of protection area to a passenger. With greater amounts of fabric needed, generally this has translated into the need for longer seams to connect and attach fabric panels, which in turn translates into greater amounts of time needed for sewing, and the like, operations. Thus, a need exists to produce high available inflation airspace volume airbag cushions with minimal requirements in seam lengths to manufacture the overall cushion product. The prior art has not accorded any advancements or even discussions to this effect.

Furthermore, since the costs of producing airbag fabrics are relatively high and there is a general need to reduce such costs, there is a consequent need to more efficiently make use of the fabric by lowering the amount which needs to be cut (cutting operations also translate into higher labor costs), reducing the amount of fabric used in order to provide substantially lower packing volumes (in order to reduce the size of the airbag modules in cars since available space on dashboards, doors, and the like, are at a premium within automobiles), and reduce the shipping weight of such products (which translates into lower shipping costs), as well as other highly desired reasons. However, it has been problematic to reduce such utilized fabric amounts in the past without consequently also reducing the available inflation airspace volume within the cushion product. There is a need then to reduce the amount of time to produce airbag cushions while simultaneously providing the lowest amount of fabric and simultaneously allow for a sufficient volume of air (gas) to inflate the target airbag cushion during an inflation event (herein described as "available inflation

comprises all substantially straight seams to attach its plurality fabric components together (although as noted above, other configured seams may also be used as long the overall required effective seam usage factor is met). A further object of this invention is to provide an easy-to-assemble airbag cushion which is minimally labor-intensive to manufacture, requires much lower fabric costs due to a substantial reduction in the overall requirement of utilized fabric amounts, and which also comprises an integrated looped pocket for the disposition of an inflator can within the airbag cushion. It is still a further object of this invention to provide a vehicle restraint system comprising an airbag cushion which provides the maximum amount of available inflation airspace volume simultaneously with the lowest length of seam (or seams) and lowest amount of utilized fabric necessary to manufacture the cushion. Another object of the invention is to provide a method of making a low cost airbag cushion (due to low levels of labor required to sew the component parts together and reduced amount of fabric to manufacture and cut) of simple and structurally efficient design.

To achieve these and other objects and in accordance with the purpose of the invention, as embodied and broadly described herein, the present invention provides an airbag cushion having at least two fabric components connected by at least one seam, wherein said airbag cushion possesses an effective seam usage factor of less than 0.11 and possesses an effective fabric usage factor of less than about 0.0330. The seam usage factor is derived from a seam usage index which concerns (and is defined as) the quotient of the total length of all seams present within the airbag cushion (measured in meters) over the total volume of available inflation airspace

very low with a correspondingly high available inflation airspace volume. Of course, this airspace volume will be the same for each factor since the measurements of both factors (seam usage and fabric usage) are made for the same bag. Such an airbag cushion must have at least two fabric panels which require connection through the utilization of very small seam lengths (preferably, again, substantially straight seams). The inventive bag is able to provide high available inflation airspace volumes due to the particular configurations of these fabric panels. The configurations permit more efficient utilization of fabric webs by cutting panels from the webs and producing less waste of unused fabric. Furthermore, fabric panels can be connected together, preferably, by placing one over the other (if both are of the same configuration) and sewing both panels together; or similarly shaped portions of a single fabric panel may be folded over on top of each other and connected by a seam. This two-dimensional cushion then can be inflated into a three-dimensional object upon an inflation event and provide the required amount of coverage to protect a passenger during a collision. The preferred embodiment is discussed in greater detail below.

The effective fabric usage factor (as defined within the correlating seam usage index formula, above) for the inventive airbag cushion then is preferably less than about 0.033, more preferably less than 0.030, still more preferably less than 0.029, even more preferably less than 0.028, and most preferably lower than 0.027. Thus, the volume of available inflation airspace within the airbag cushion should be as great as possible with the amount of fabric utilized reduced to its absolute minimum while still providing sufficient protection to a passenger in an automobile during a collision event.

(opposite the large opening) will have extra fabric which can be overlapped (to provide extra reinforcing fabric at the point of potential inflation) and sewn to form the desired pocket in which to dispose the inflation can. This embodiment is discussed below in greater detail.

Additional objects and advantages of the invention will be set forth in part in the description which follows, and in part will be obvious from the description, or may be learned by practice for the invention. It is to be understood that both the foregoing general description and the following detailed description of preferred embodiments are exemplary and explanatory only, and are not to be viewed as in any way restricting the scope of the invention as set forth in the claims.

Brief Description Of The Drawings

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate several potentially preferred embodiments of the invention and together with the description serve to explain the principles of the invention wherein:

FIG. 1 is an aerial view of a portion of a fabric web with lines indicating the specific preferred locations for cutting to form two sets of fabric panels to manufacture two separate inventive cushions, each for the inclusion within a vehicle restraint system configured within a module which is stored substantially vertically.

FIG. 2 is an aerial view of a preferred cut fabric panel with second and third smaller preferred cut panels connected thereto.

FIG. 3 is an aerial view of the connected preferred cut fabric panels showing

the first folding step in producing the mouth portion of the target cushion.

FIG. 13 is an aerial view of the connected preferred cut fabric panels showing the second folding step in producing the mouth portion of the target cushion.

FIG. 14 is an aerial view of the connected preferred cut fabric panels showing the third folding step in producing the mouth portion of the target cushion as well as the entire connected fabric panel composite folded over and connected to itself.

FIG. 15 is an aerial view of the preferred cut fabric front panel of the target cushion.

FIG. 16 is a front view of the finished target cushion showing the preferred front panel and the substantially straight seams connecting the front panel to the remaining preferred cut fabric panels.

FIG. 17 is a side view of the finished, unfolded, and non-inflated, target cushion.

FIG. 18 is a cut-away side view of a vehicle for transporting an occupant illustrating the deployment of an inflatable restraint cushion within a vehicle restraint system according to the present invention.

FIG. 19 is an aerial view of a portion of a fabric web with lines indicating the specific preferred locations for cutting to form two sets of fabric panels to manufacture two separate inventive cushions, each which provide means for an integrated mouth to form a pocket for the disposition of an inflation can therein.

FIG. 20 is an aerial view of a preferred cut fabric panel with second and third smaller preferred cut panels connected thereto.

FIG. 21 is an aerial view of the connected preferred cut fabric panels showing

reference numerals throughout the various views, in **FIG. 1** there is shown a fabric web **10**, wherein eight fabric panels to be cut **12, 14, 16, 18, 20, 22, 24**, and **26** have been outlined. Also, specific fabrics pieces to be removed and slits **28, 30, 32** within the two largest fabric panels **12, 14** are outlined as well. The fabric web **10** in this specific example comprised nylon 6,6, 630 denier yarns, woven on a jacquard loom into a fabric **10** comprising 41 picks by 41 ends per inch.

In **FIG. 2**, two smaller preferred fabric panels **16, 18** have been connected to one preferred large fabric panel **12** by substantially straight seams **34, 36, 38, 40**. The composite fabric structure now has two small fabric portions **39, 41** uncovered by the two smaller fabric panels **16, 18**. The free space **30** remains and an imaginary straight line **42** denotes the future fold line within the fabric composite of the fabric panels **12, 16, 18**.

In **FIG. 3**, tie-rods **42, 44** have been placed over the small fabric portions **39, 41** parallel to the seams **38, 40**, and the fabric portions **39, 41** have been folded back in a manner to form a right angle at the point of contact between the two portions **39, 41**.

In **FIG. 4**, the small fabric portions **39, 41** have been folded over once again and seams **35, 37** have been produced to connect the fabric portions **39, 41** to themselves and to the smaller fabric panels **16, 18**. The folded over fabric portions **39, 41** provide reinforcement in order to withstand inflation pressures at the mouth opening of the cushion.

In **FIG. 5**, the fabric panel **12** has been folded over imaginary line **42** (in half) leaving one smaller fabric panel **16** in view (the other is not illustrated as it is now

one preferred large fabric panel **112** by substantially straight seams **144, 146, 148**. The composite fabric structure now has two small fabric portions **131, 150, 152** uncovered by the two smaller fabric panels **116, 118**. An imaginary straight line **142** denotes the future fold line within the fabric composite of the fabric panels **112, 116, 118**, which is noticeably off-center in order to ultimately allow for the bag to be deployed at an angle from a horizontally disposed dashboard (not illustrated).

In **FIG. 12**, tie-rods **153, 155** have been placed over the small fabric portions **150, 152** and have been folded back over the tie-rods **153, 155** as shown, folded again, as in **FIG. 13**, and connected to themselves by seams **152, 156**. The folded over fabric portions **150, 152** provide reinforcement in order to withstand inflation pressures at the mouth opening of the cushion.

In **FIG. 14**, the fabric panel **112** has been folded over imaginary line **142** leaving one smaller fabric panel **116** in view (the other is not illustrated as it is now located on the bottom portion of fabric panel **112** directly beneath smaller fabric panel **118**). A seam **158** connects fabric panel **112** to itself and also connects the smaller fabric panels **116, 118** both to the larger panel **112** and to themselves. Upon unfolding of the connected composite, the non-connected ends of the panel **112** will form the same shape as the front panel **124** of **FIG. 15**. **FIG. 16** then shows the seam **159** needed to sew the non-connected ends of the large panel **112** (of **FIG. 14**), and **FIG. 17** provides a side view of the finished cushion **160**.

FIG. 18 shows a fully deployed inflatable restraint cushion **160** in opposing relation to an occupant **162** located on the front seat **164** of a vehicle **166** such as an automobile, airplane, and the like. As shown, the cushion **160** may be outwardly

252 needed to sew the non-connected ends of the large panel 212 (of **FIG. 21**), and **FIG. 24** provides a top view of a finished cushion 246 and **FIG. 25** provides a side view of a finished cushion 250 after all the connection through seams 234, 244, 248 have been made.

FIG. 26 shows a fully deployed inflatable restraint cushion 260 in opposing relation to an occupant 262 located on the front seat 264 of a vehicle 266 such as an automobile, airplane, and the like. As shown, the cushion 260 may be outwardly deployed from the dash panel 267 through an inflation means 268 from a position directly opposite the occupant 262. It is to be understood, however, that the cushion 260 may likewise be deployed from any other desired location in the vehicle 266 including the steering wheel (not illustrated), the vehicle side panels (not illustrated), the floor (not illustrated), or the backrest of the front seat 264 for disposition in opposing relation to a rear passenger (not illustrated).

These specific configurations and shapes provide the lowest overall seam usage and fabric usage, both as compared to the available inflation airspace volume. Specific measurements for each inventive cushion manufactured in this configuration (but with different amounts of fabric utilized) are further described in the Tables below.

Each of the panels utilized in these preferred embodiments may be formed from a number of materials including by way of example only and not limitation woven fabrics, knitted fabrics, non-woven fabrics, films and combinations thereof. Woven fabrics may be preferred with woven fabrics formed of tightly woven construction such as plain or panama weave constructions being particularly preferred.

fluid jet weaving may be most preferred, although, as noted previously, weaving on jacquard and/or dobby looms also permits seam production without the need for any further labor-intensive sewing or welding operations.

In the event that a coating is utilized on one or more material panels, neoprene, silicone urethanes or disperse polyamides may be preferred. Coatings such as dispersed polyamides having dry add on weights of about 0.6 ounces per square yard or less and more preferably about 0.4 ounces per square yard or less and most preferably about 0.3 per square yard or less may be particularly preferred so as to minimize fabric weight and enhance foldability. It is, of course, to be understood that aside from the use of coatings, different characteristics in various panels may also be achieved through the use of fabrics incorporating differing weave densities and/or finishing treatments such as calendaring as may be known to those in the skill of the art.

While the airbag cushions according to the present invention have been illustrated and described herein, it is to be understood that such cushions may also include additional components such as shape defining tethers, gas vents, and the like as may be known to those in the skill of the art.

With regard to comparable airbag cushions, the following table presents comparative seam usage factors for other well known and commercially available airbag cushions. The labels used are those used within Standard & Poor's DRI, a well known publication which denotes many different types of products offered for sale to the automotive industry.

cushions. The dimensions, seam usage factors, and fabric usage factors for the inventive bags (which compare with those in Tables 1 and 2, above, directly, and as noted) are presented below in tabular form and are the same general shape as those presented within the drawings described above (but with larger pieces of fabric panels, etc.):

TABLE 3

Seam Usage Index Factors for Inventive Airbag Cushions in Correlation to the S&P DRI Numbered Airbag Cushions Requiring Similar Dimensions and Performance Characteristics

Correlated Bags by S&P DRI Number	Total Length of Total Seams (m)("A")	Available Inflation Airspace Volume (L)("B")	Seam Usage Factor (A/B)
GM-C4	7.56	95.00	0.0796
W202	6.90	129.00	0.0535
GM4200	7.20	90.00	0.0800
414T	6.90	128.00	0.0539
CY	5.35	128.00	0.0418
CF	6.90	128.00	0.0539

TABLE 4

Fabric Usage Index Factors for Inventive Airbag Cushions in Correlation to the S&P DRI Numbered Airbag Cushions Requiring Similar Dimensions and Performance Characteristics

Correlated Bags by S&P DRI Number	Total Amount of Fabric Used (m)("C")	Available Inflation Airspace Volume (L)("B")	Fabric Usage Factor (C/B)
GM-C4	2.41	95.00	0.0253
W202	3.50	129.00	0.0271
GM4200	2.58	90.00	0.0287
414T	3.64	128.00	0.0284
CY	3.64	128.00	0.0284
CF	3.50	128.00	0.0273

Clearly, the inventive bags, which possess the same available inflation airspace volume and front fabric panel area as the comparative prior art commercially

Claims

What I claim is:

1. An airbag cushion comprising at least one seam in order to connect either (a) at least two fabric panels or (b) at least two portions of a single fabric panel, wherein said airbag cushion possesses an effective seam usage factor of less than 0.11 and possesses an effective fabric usage factor of less than about 0.0330.

2. The airbag cushion of Claim 1 wherein said airbag cushion possesses an effective seam usage factor of less than about 0.10 and possesses an effective fabric usage factor of less than about 0.030.

3. The airbag cushion of Claim 2 wherein said airbag cushion possesses an effective seam usage factor of less than about 0.09.

4. The airbag cushion of Claim 2 wherein said airbag cushion possesses an effective fabric usage factor of less than about 0.029.

5. The airbag cushion of Claim 3 wherein said airbag cushion possesses an effective seam usage factor of less than about 0.07.

15. A vehicle restraint system comprising the airbag cushion of Claim 5.

16. A vehicle restraint system comprising the airbag cushion of Claim 6.

17. A vehicle restraint system comprising the airbag cushion of Claim 7.

18. A vehicle restraint system comprising the airbag cushion of Claim 8.

19. A vehicle restraint system comprising the airbag cushion of Claim 9.

20. The airbag cushion of Claim 1 wherein at least one seam present within said airbag cushion is substantially straight.

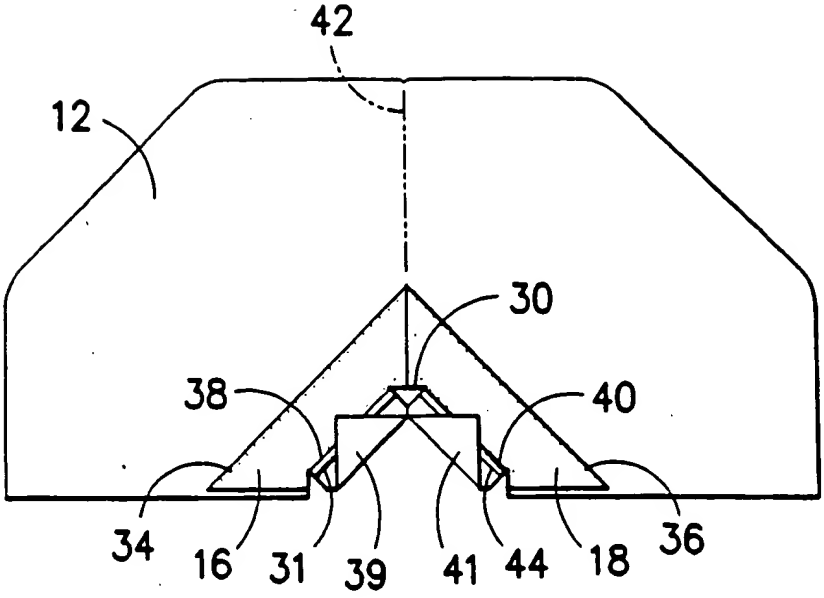
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FIG. -3-

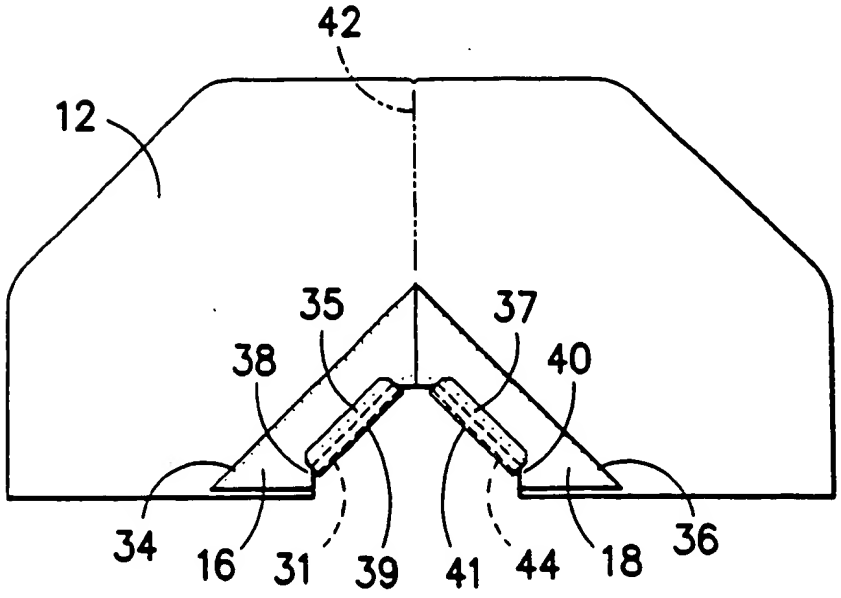
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FIG. -4-

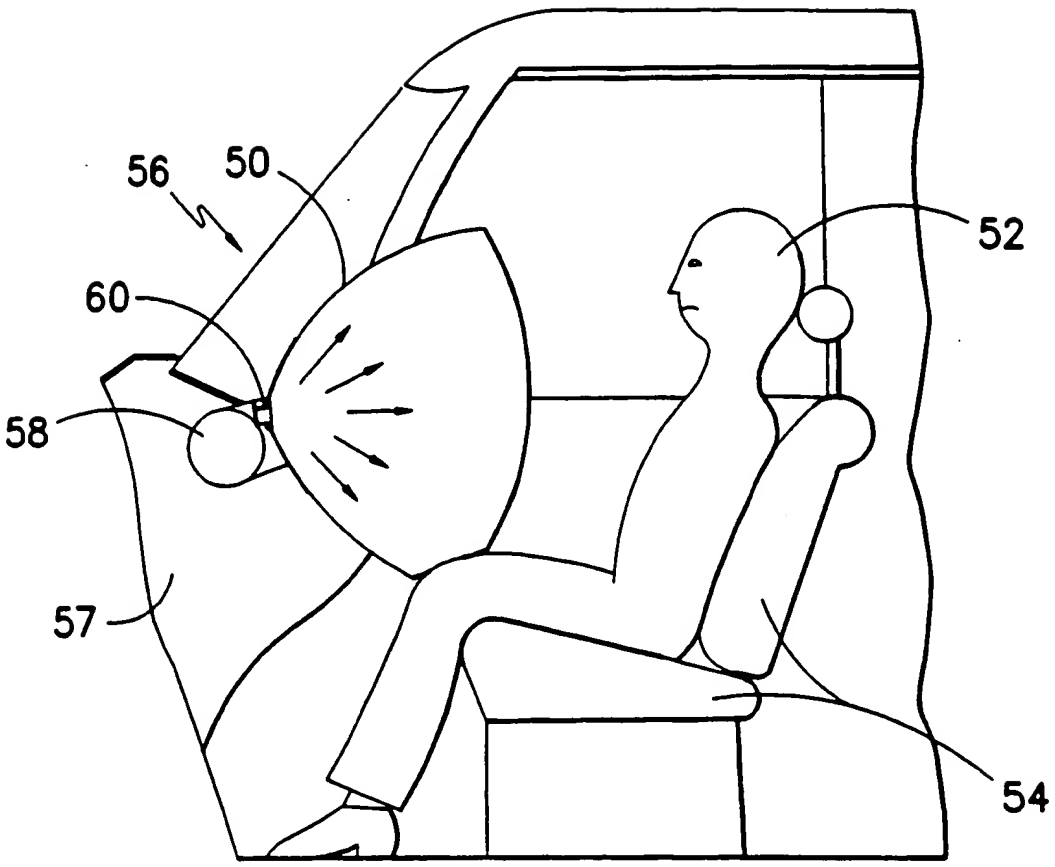

FIG. -9-

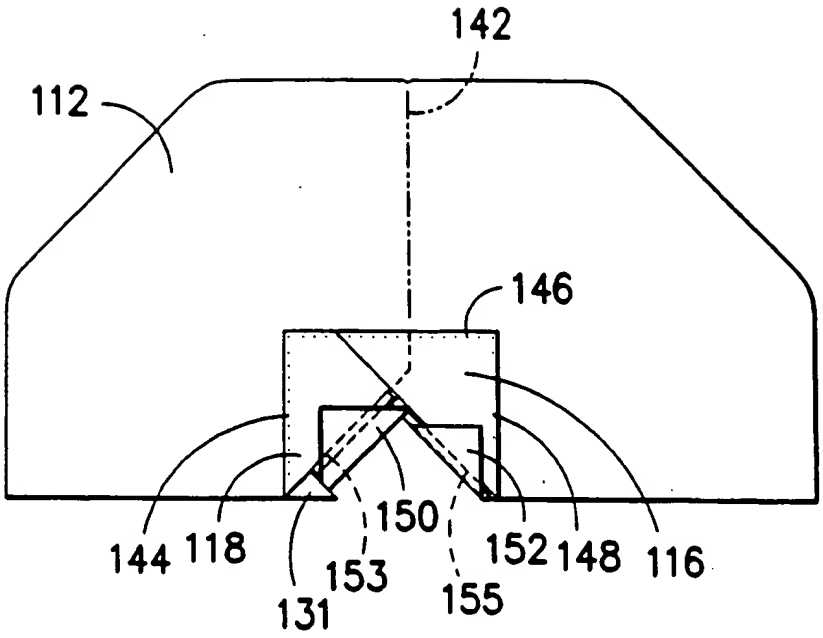
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FIG. 12–

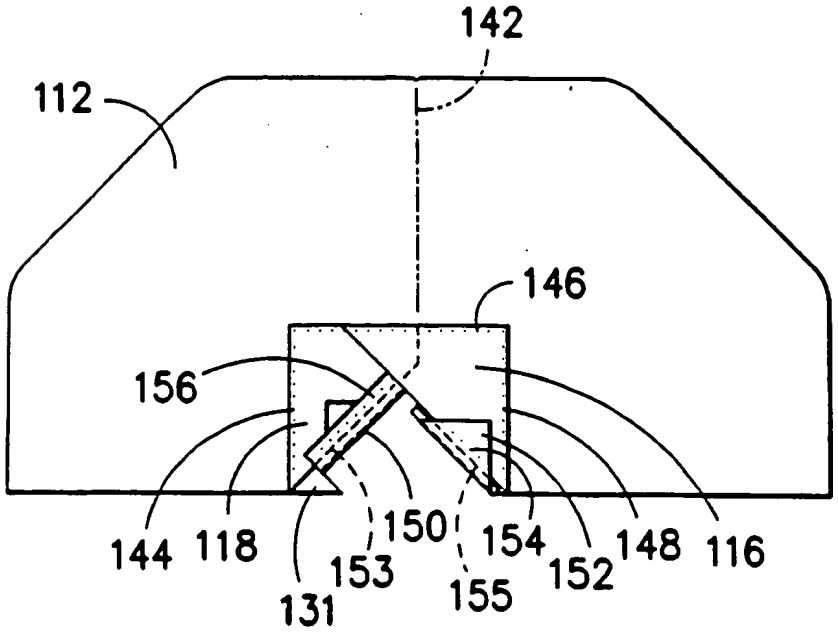
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FIG. –13–

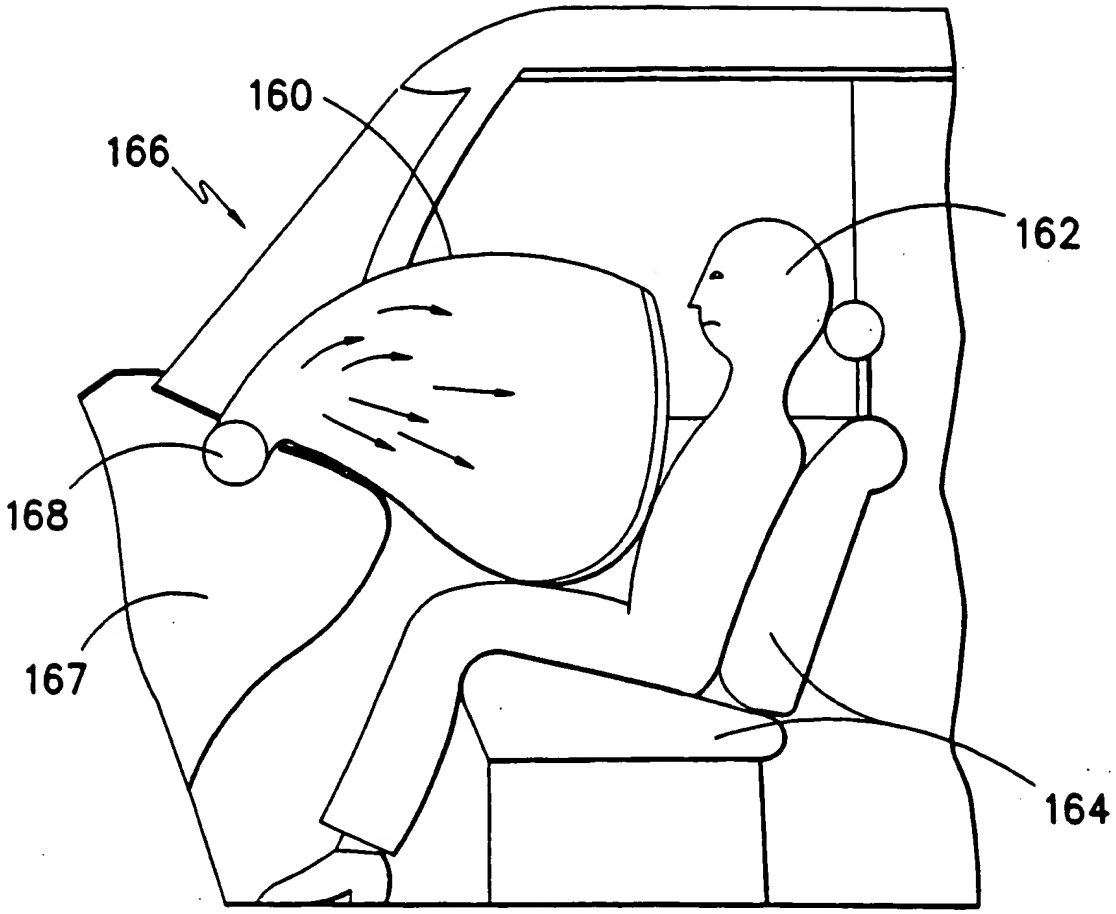

FIG. -18-

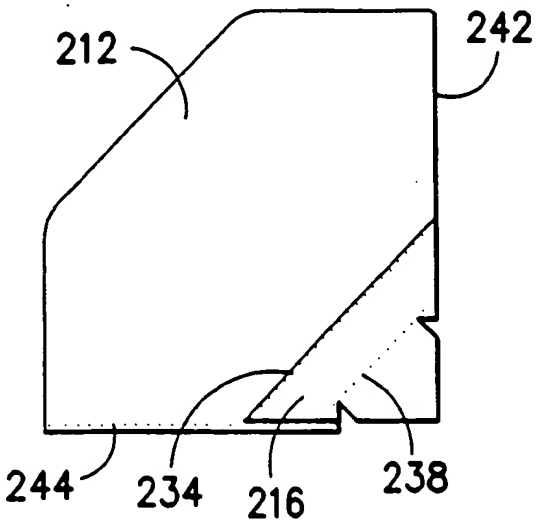

FIG. -21-

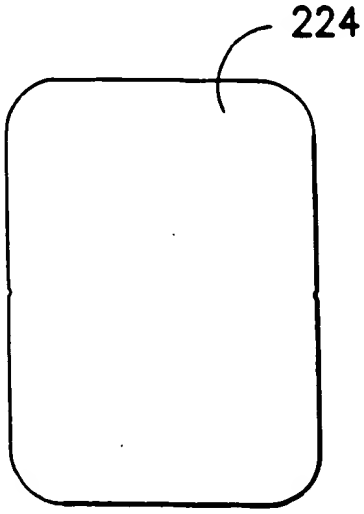

FIG. -22-

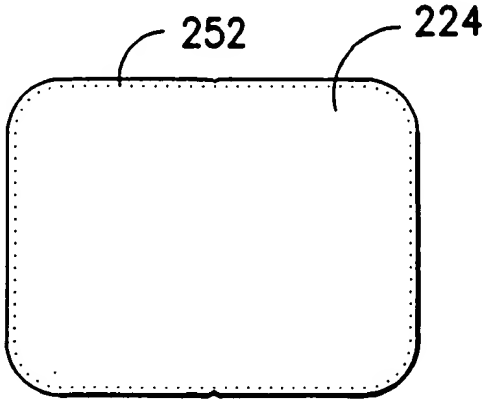

FIG. -23-

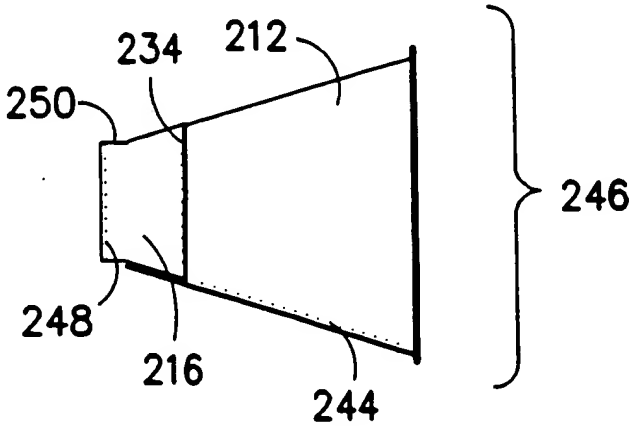

FIG. -24-

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/18848

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :B60R 21/16
US CL : 280/743.1

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 280/743.1;728.1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,533,755 A (NELSEN et al) 09 July 1996, see entire document.	1-20
A	US 4,944,529 A (BACKHAUS) 31 July 1990, see entire document.	1-20

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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